Endovascular Treatment for a Penetrating Vertebral Artery Injury

- Case Report -

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The vertebral artery injuries are rare in frequency and penetrating injuries are most likely to damage the vertebral artery as a sort of a collateral damage from striking the bony cervical spine. A 49-year-old man was struck in the face with a metal bar. The plain skull X-ray showed a long nail penetrating from the maxilla to the suboccipital area. Digital subtraction angiography revealed an injury of the left vertebral artery with a strong retrograde flow down the rostral segment and a filling with thrombus within the distal portion from injured segment. The patient underwent Guglielmi detachable coils embolization for complete isolation of the injured segment. The manual removal of the foreign body was attempted and was successfully completed.

KEY WORDS : Endovascular occlusion · Therapeutic embolization · Trauma · Vertebral artery.

Introduction

Although trauma of the vertebral artery is uncommon, with a reported frequency of 3% to 19% of all cervical vascular injuries[6], it can pose one of the most challenging surgical approaches. The operative isolation and control of an injured vertebral artery is difficult, resulting in an appreciable morbidity and mortality. The recommended treatments have ranged from observation alone to direct surgical repair. Endovascular treatment may offer a theoretical advantage in permitting aggressive anticoagulation therapy before deficits develop[1]. If a foreign body is to be removed, the injured segment must be isolated completely. Therefore, the proximal and the distal portions of the injured segment need embolization with balloons or coils. This article focuses on the endovascular guglielmi detachable coils embolizations for occlusion of the distal portion of the injured segment. Additionally, we present a case of penetrating injury of the vertebral artery with discussion of its treatment options.

Case Report

A 49-year-old man was struck in the face with a metal bar used for interior decoration of apartment. This metal bar was a large tack, about 20cm in long axis. He came to the hospital complaining of pain in the maxilla and posterior neck and could not open his mouth(Fig. 1). His vital signs were stable. Physical examination revealed an abrasion in the left side of face, no evidence of vascular injury, and no definite neurological deficit.

Fig. 1. Photograph showing a metal bar in the face which is a large tack, about 20cm in long axis.

The plain skull X-ray showed a long nail penetrating from the maxilla to the suboccipital area(Fig. 2). There was no definite cervical spine fracture on plain X-ray. Initially, oral-maxillofacial department managed the patient because of the facial injury, and later he was referred to department of neurosurgery. Computed tomography or Magnetic resonance imaging was not suitable due to artifacts by the foreign metal body. With a suspicious vascular injury, emergency intra-arterial digital subtraction angiography(DSA) was performed.

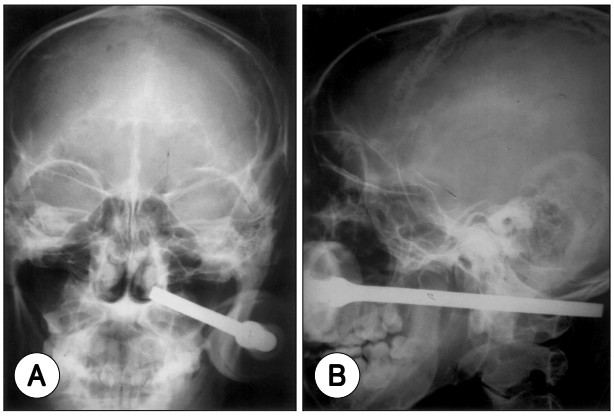

Fig. 2. Plain skull X-ray(A : anteropsoterior B : lateral) showing a long nail penetrating from the maxilla to the suboccipital area. There was no definite cervical spine fracture on plain X-ray.

Both carotid angiograms were normal. DSA of the right vertebral artery revealed an injury of the left vertebral artery with a strong retrograde flow down the rostral segment and a filling with thrombus within the distal portion from injured segment. In the left vertebral angiogram, vertebral artery was occluded at the level of C1-2 junction(Fig. 3).

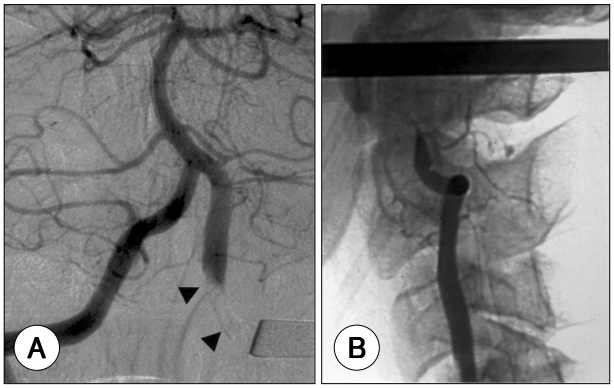

Fig. 3. Digital subtraction angiogram of the right vertebral artery(A) revealing injury of the left vertebral artery with strong retrograde flow down the rostral segment and a filling with thrombus(arrowhead) within the distal portion from the injured segment. In left vertebral angiogram(B), vertebral artery being occluded at the level of C1-2 junction.

Under the local anesthesia, the patient underwent Guglielmi detachable coils(GDCs) embolization for complete isolation of the injured segment. First, embolization of the distal portion of the injured segment was tried because the proximal portion was thought to have already occluded by thrombus. A contralateral approach was undertaken to the distal portion of the injured segment of the left vertebral artery, using a 8-French MPA guide(Cordis Endovascular, Miami, FL) in the right vertebral artery and a 3.2-French Rapid Transit microcatheter(Cordis Endovascular, Miami, FL) after the systemic heparinization with a 5000-U bolus followed by hourly boluses of 2500 U and monitoring of the activated clotting time. Microcatheter had to pass the right vertebral to the basilar artery and down the segment of distal left vertebral artery. After the selective catheterization of the distal portion of the left vertebral artery, a 4-mm by 8-cm 2D-shape GDC-10 coil was deployed within the left vertebral artery. Subsequently, three additional conventional GDC-10 coils were deployed and detached ; these consisted of two coils measuring 3mm by 6cm and one coil measuring 3mm by 4cm. The angiogram of the right vertebral artery showed a complete occlusion of the distal portion of the left vertebral artery. Subsequently, microcatheter was placed at the proximal portion of the left vertebral artery to perform selective arteriogram. A contrast material leaked from the proximal portion of the injured segment(Fig. 4). Consequently, a 4-mm by 8-cm conventional GDC-10 coil was deployed within the left vertebral artery. Subsequently, five additional conventional GDC-10 coils were deployed and detached ; these consisted of three coils measuring 3mm by 6cm and two coils measuring 3mm by 4cm. The final angiography demonstrated a perfect occlusion of the injured segment of the left vertebral artery. After endovascular treatment, the patient was transferred to the operating room due to possibility of failure of simple extraction resulting from tight and deep impaction. After the preparation of an open surgery, the manual removal of the foreign body

Fig. 4. Magnified unsubtracted view(A) showing microcatheter had to be passed the right vertebral to the basilar artery and down the segment of distal left vertebral artery. Digital subtraction angiogram in anteroposterior projection(B) demonstrating complete occlusion of the distal portion of the left vertebral artery. Selective angiogram of the left vertebral artery(C) showing that contrast material was leaked from the proximal portion of the injured segment.

Fig. 5. Facial computed tomography demonstrating a left anterior arch fracture of the atlas(arrow). High density (arrowhead) was coils in the left vertebral artery.

Fig. 6. Follow-up angiogram of the right vertebral artery showing an antegrade advance of the thrombus, but saved left posterior inferior cerebellar artery. The Proximal(arrow) and distal coils(arrowhead) are well located on the lumen of the left vertebral artery.

was attempted and was successfully completed. After the procedure, the patient remained unchanged neurologically ; after a short stay in the intensive care unit to optimize his heparinization, he was transferred to the general ward. The patient underwent facial computed tomography, which demonstrated a left anterior arch fracture of the atlas (Fig. 5). The follow-up angiogram of the right vertebral artery showed an antegrade advance of the thrombus, but saved left posterior inferior cerebellar artery(Fig. 6). He took antiplatelet medication (clopidogrel ; plavix) and stopped medication on discharge. One year posttreatment, his neurological status remains stable, with no radiographic evidence of thrombus progression on the angiogram.

Discussion

The vertebral artery injuries are the least common arterial injuries because of their location deep in a bony canal. Even as late as 1956, a mortality of 50% was reported[3]. Most reported cases of the cervical vertebral artery trauma occurred in the setting of blunt cervical trauma. These injuries have been associated with cervical spine fractures, chiropractic manipulation, and sports injuries[2]. A penetrating injury is most likely to damage the vertebral artery as a sort of a collateral damage from striking the bony cervical spine. The vertebral artery is surrounded for most of its course through the neck superior to C-7 through the transverse processes of C-6 to C-1. A cervical fracture secondary to a missile injury or penetrating injury by a foreign body should raise suspicion of a vertebral artery injury and appropriate diagnostic measures should be employed. In our case, the computed tomography or MR imaging was not appropriate to diagnose due to the artifacts by the foreign metal body. Angiography was performed simply because of suspicion of the vertebral artery injury and cervical spine fracture. In the plain x-ray films of the cervical spine that demonstrate a fracture from being struck by a bullet, the cervical spine should be considered to harbor an injury to one or both vertebral arteries until proved otherwise. Again, the gold standard is angiography in the detection of these lesions, with MR imaging playing an expanding role.

Treatment options depend on the severity of the lesion and its anatomic location. Patients with a complete vertebral artery thrombosis, who are asymptomatic and found to have an intact contralateral vertebral artery, warrant no further therapy[1]. This would be unusual in the setting of adequate flow from the contralateral vessel, however. Those patients with significant neurologic deficit with a vertebral artery thrombosis undergoing attempts at thrombectomy or thrombolysis are not generally benefited[10]. In this group of patients, the best therapy may be a trial of induced hypervolemia and hypertension to try to reduce ongoing ischemia[10].

The patient presenting with a dissection of the vertebral artery from a penetrating injury should be initiated on anticoagulant therapy. Anticoagulation should be continued for a period to up to 6 months[1]. Surgical intervention may be indicated in those cases in which there is a progression of neurologic deficits either to worsening dissection or embolic phenomenon. If the contralateral vertebral artery is not hypoplastic or aplastic, proximal clip ligation is the one option for the treatment. Trapping the involved segment is not necessary with adequate flow in the contralateral vessel. In the situation in which the injured vessel is strongly dominant, consideration must be given to repair of the injured segment. In lieu of reconstruction of the segment, consideration may also be given to EC-IC bypass grafting with ligation of he injured vessel directly or by balloon occlusion. The introduction of interventional radiologic techniques has provided an alternative to direct surgical ligation or repair of these injuries[6,9]. The great majority of vertebral artery injuries are identified angiographically, affording the opportunity for the emboliza-

tion[4,6,7]. Neurologic sequelae of occlusion of this vessel by angiographic embolization are unusual[4], and are considered especially unlikely with unilateral injuries in the presence of a normal contralateral vessel, and in the absence of either neurologic deficit or any arteriographic demonstration of branch vessels to the spinal cord[4]. After the tolerance to test occlusion has been established, the embolic device is delivered to the dissection site, producing occlusion of the dissecting aneurysm and flow in the involved vertebral artery[6,9]. Both the balloons and the coils were successful in achieving this goal. The electrolytically detachable coils, although initially designed for the saccular aneurysms with narrow necks, work exceedingly well at producing the occlusion of the fusiform aneurysms such as the dissecting aneurysms[8]. These coils also permit the occlusion of a vessel in a relatively short segment.

The gap between proximal and distal segments, as well as the retrograde flow that occurs in the distal segment should tend to prevent intracerebral migration. However, this risk may be significant in injuries involving only a partially transected the vertebral artery. Thus any attempt at angiographic embolization of such an injury must be preceded by injection of contrast medium to define the specific anatomy involved. If the antegrade flow is shown beyond a tangential laceration, the introduction of an occluding balloon or coils into the distal vessel over a guidewire has been described as effective. The techniques for balloon or coils occlusion of this distal segment via the contralateral vertebral artery have also been developed[5,8]. Microcatheter was passed up the contralateral vertebral artery to the level of the basilar artery and then retrograde down the distal left vertebral artery to the lesion for successful placement of GDCs. In our case, the injured segment must be isolated completely from the proximal to the distal portions before the removal of foreign body. Simply the embolizing the vertebral artery proximally may decrease the flow, but will not stop it. Such as our case of no distal accessibility across the injured segment, the distal segment must be embolized by contralateral approach after obtaining of perfect control of the proximal portion.

Conclusion

A cervical fracture secondary to penetrating injury by a foreign body should raise suspicion of a vertebral artery injury and the appropriate diagnostic measures should be employed. The injured segment must be isolated completely from the proximal to the distal portions before the removal of foreign body. The distal segment must be embolized by contralateral approach after obtaining of perfect control of the proximal portion if it can be accessible across the contralateral vertebral artery.

• **Received** : May 6, 2002
• **Accepted** : July 19, 2002
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